Ex post evaluation – People's Republic of China

Sector: Wind energy (CRS code: 2324000)
Project: Wind Energy Programme, PR China (BMZ No. 2000 65 789)
Implementing agency: A partly state-owned wind power project developer

Ex post evaluation report: 2018

		Project (Planned)	Project (Actual)
Investment costs (total)	EUR million	43.00	38.19
Counterpart contribution	EUR million	22.55	24.15
Financing	EUR million	20.45	14.04

*) Random sample 2016

Summary: The project included investments for building a wind farm in Dabancheng, Xinjiang in the PR of China. The project included financing 39 wind power plants with a 750 kW capacity each (first project phase financed through own funds from the executing agency) and 10 wind power plants with a 2 MW capacity each (second project phase financed with FC funds). The total installed capacity is thus 49.25 MW, 20 MW of which were financed using FC funds.

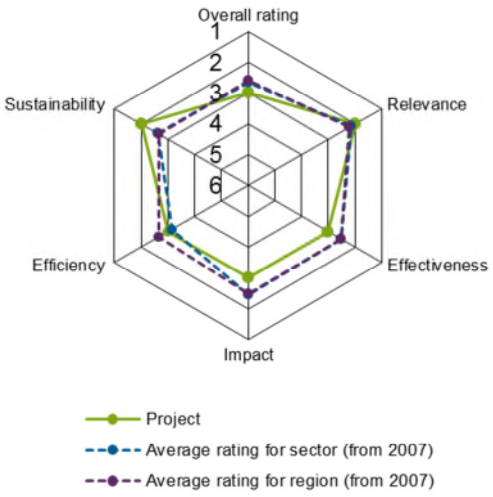
Development objectives: The project objective (outcome) was the efficient and environmentally friendly provision of energy. The overarching development policy target (impact) was to contribute to protecting the climate and promoting economic development in the region.

Target group: The indirect target group included all electricity consumers in Xinjiang Province (part of the State Grid of China) and the global community in the context of climate protection as a global public good. A partly state-owned wind power project developer benefited directly from the measure.

Overall rating: 3

Rationale: The project contributed to transitioning the Chinese electricity system to renewable energy sources. However, the indicators for electricity feed-in were not fulfilled due to excess capacity in the power sector on the generation side, and the associated curtailment of the wind farm by the power grid operator. A significant improvement to the electricity feed-in and thus to carbon savings in the coming years is expected due to various regulatory reforms supporting wind power. The executing agency operates the farm efficiently and profitably. No negative social or environmental impacts were observed. The additionality and the example set by the project are low due to its implementation at an advanced stage of the introduction of wind power to the Chinese market.

Highlights: The percentage of coal-fired power plants in the power plant fleet sank from 78% to 68%, while power consumption increased by 22% annually between 2009 and 2016. In this respect, we can assume that the strong development of wind energy in the project region replaced the capacity-building for coal-fired power plants.



Rating according to DAC criteria

Overall rating: 3

Ratings:

Relevance	2
Effectiveness	3
Efficiency	3
Impact	3
Sustainability	2

Relevance

Financing plants for generating electricity from renewable sources of energy is generally a relevant FC contribution to environmental protection and mitigating climate change. This applies especially in periods of dynamic economic growth, when there is high demand for quickly adding new capacity for electricity generation. The approach is in line with the strategy of the Federal Ministry for Economic Cooperation and Development (BMZ) for the energy sector, and at the time of the project appraisal it was part of the "Environmental policy, protection and sustainable use of natural resources" priority area in development cooperation with China. Furthermore, it potentially contributed to MDG 7: "Ensure environmental sustainability". The project was part of extensive efforts by the Chinese central government to expand wind power. The major role wind power plays in transforming the Chinese power system is highlighted in both of the five-year plans since 2011. Wind power is viewed as a key technology for the overarching objective of using 15% non-fossil fuel sources by 2020 to cover primary energy demand.[1] Expanding (clean) energy generation capacities has been a priority area of provincial government policy in Xinjiang in recent years as well.

The main problem in the north-western province of Xinjiang was the sharp increase in energy consumption (an average of 22% annually between 2006 and 2015[2]). The energy supply bottlenecks that arose or were feared were met with a massive increase in capacity of conventional and renewable power generation capacities.

The high level of environmental pollution, particularly in the area surrounding the provincial capital of Urumchi caused by the coal-fired power plants for generating power and heat in that area, was a further key problem at the time of project implementation. The issue of air pollution is still relevant today due to the addition of conventional power plants in past years, the establishment of heavy industry and increased vehicular traffic.

The efficient and environmentally friendly provision of electrical energy from wind power plants was thus also suitable for solving the core problem in Xinjiang's energy sector from today's perspective. In this sense, the project was coherent with the strategies of the provincial and central governments for economic development in the province and for wind power in past years.

The expected chain of resultsl is plausible: the additional provision of renewable energy sources can contribute to covering the increased demand for electricity and thus facilitate economic development in the region. Due to the site conditions in Dabancheng, wind power is efficient and environmentally friendly. Its expansion thus has the potential to reduce air pollution from coal-fired power plants and greenhouse gases in power production and consequently contribute to the mitigation of climate change.

Relevance rating: 2

[1] GIZ 2017: Deutsche Gesellschaft für Internationale Zusammenarbeit, Sino-German Energy Partnership, China Policy Brief, 03/2017.
[2] NBS 2018: National Bureau of Statistics, Annual Statistics per Province, Consumption of Electricity, http://data.stats.gov.cn/english/.

Effectiveness

The project objective was the efficient and environmentally friendly provision of energy (supply and use tallying with each other). The indicator defined during the project appraisal for the amount of electrical energy supplied was not achieved due to curtailments by the grid operator (see below). On the other hand, the electricity generation costs developed very positively; they are 50% below the previously defined target value. The indicator defined during the project appraisal for the volume of CO_2 emissions saved was not achieved due to lower grid feed-in (all indicators pertain to the entire wind farm).

Indicator	PA target value	Ex post evaluation
(1) Annual amount of electrical energy fed into the main grid (State Grid of China)	128 GWh/y	109 GWh/y (Average 2013-2017)*
(2) Maximum dynamic production costs (levelized costs of electricity)	0.433 CNY/kWh (0.056 EUR/kWh)**	0.224 CNY/kWh (0.029 EUR/kWh)**
(3) Preventing climate-impacting emissions p.a.	119,500t CO_2***	99,200t CO_2***

* Grid feed-in 2013-15: average 127 GWh/y;

* Grid feed-in 2016-17e: average 82 GWh/y (limitation by grid operator)

** Average exchange rate 2012–2017 according to ECB: EUR/CNY 7.73

*** CO_2-savings 2013-15: average 118,184t CO_2/y;

CO_2-savings 2016-17e: average 70,748t CO_2/y (due to lower feed of electrical energy, see above)

Regarding the development of grid feed-in it should be noted that the wind farm fed an average of 127 GWh/y into the grid in the first years of operation, which meant it nearly achieved the target value. From 2016 the grid feed-in of electrical energy was reduced by around 35% to an average of 82 GWh/y by the grid operator (curtailment). These measures not only affected the co-financed wind farm, the curtailment rate for wind power plants throughout the entire province of Xinjiang was 38% on average in 2016.[3] Following the low feed-in of the wind farm since 2016, the carbon savings of the project were also below the target value of the project appraisal. This development is primarily attributed to the following three factors:

Building excess capacity in Xinjiang's power sector: contrary to the situation during the appraisal, this factor reversed itself and the excess capacities on the generation side are the most critical energy sector problem in Xinjiang, as is also the case in other northern Chinese provinces. The governments of the northern Chinese provinces used to receive strong incentives for creating excess capacity in the energy sector to facilitate their ability to export electrical energy for example to the load centres in the south-eastern part of the country and thus promote local economic development. For example, the grid-connected wind power capacity in Xinjiang increased from 3.2 GW (2015) to 5 GW (2016) within one year.[4] As a countermeasure, the central government limited the addition of wind power plants in the province to 1 GW from 2017-2020. Coal-fired power plant projects with a capacity of 195-295 GW were cancelled or postponed nationwide.[5]

Feeding in power on a contractual basis: the State Grid of China (SGCC), the transmission system operator, does not plan power plant resources according to economic criteria (merit order). Instead, the planning ensues according to contractual commitments with the power plant operators at prices set by the state. These contracts often contain specifications about the number of full-load hours for coal-fired power plants. This is one drawback for wind power plants, which have incremental costs close to zero and thus must be used first to cover electricity demand according to the principle of a merit order. In the context of

[3] BNEF 2017: Bloomberg New Energy Finance, China's Renewables Curtailment and Coal Assets Risk Map, 10/2017, p. 22.

[4] NBS 2016: National Bureau of Statistics, Energy Yearbook 2016.

[5] BNEF 2017, p. 69.

the current 13th five-year plan from the Chinese government, a reform of power plant resource planning according to economic criteria is being pursued with measures such as establishing wholesale markets for electricity products.

Bottlenecks in the transmission grids: due to the significant addition of wind power plants, also in connection with the financed wind farm, there have been local grid bottlenecks since 2016 that have negatively impacted on feed-in to the grid. In the medium term, the general flexibility of the power system in Xinjiang and thus the capacity of the power plant fleet is primarily dependent on the expansion of connections to other provinces. High-voltage lines with an overall capacity of 32 GW for power transmission from Xinjiang to other regions of China are currently being built; completion is planned for 2020.[6] As wind farms in China feed directly into the high-voltage grid, this massive grid expansion is also expected to have direct impacts on the feed-in of the financed project.

The measures initiated at the level of the central government thus include the relevant energy-sector areas of **generation** (increased central control of power plant capacities), **transmission** (intensifying grid expansion) and **trade** (introduction of market principles to balance supply and demand). Primarily using measures in the latter two areas, it can be expected that the flexibility in Xinjiang's electricity system will increase overall and the excess capacities will be reduced by 2020. In view of this situation, the executing agency and market observers like Bloomberg[7] and GIZ China[8] assume there will be less regulation of wind farms in the coming years.

The low dynamic production costs of 0.224 CNY/kWh are attributed to scale effects of the operator and the outstanding local wind conditions. So a central control room for the operator's wind farms and one photovoltaic farm in the Dabancheng region was set up, and the technical infrastructure for operation and maintenance was consolidated. The executing agency's management made a very good impression on site during the ex post evaluation. Small-scale repairs are performed by the operator's own trained staff with stocked spare parts. The plants seemed to be in good condition and were all functional. What's more, they are in an optimal wind location, in a wind tunnel between the southern desert areas and the more northern, cooler steppe.

Effectiveness rating: 3

Efficiency

The project measures were implemented cost-efficiently. The results were achieved with a comparatively low use of funds (production efficiency):

- The total costs were EUR 38.19 million (project phases 1 and 2). At the time of the project appraisal in 2007, the total costs were estimated at EUR 43 million. The actual costs were thus around 11% below the budgeted figure. This can primarily be attributed to the reduced costs for wind power plants; for comparison, in the period 2007 to 2012, such costs fell by around 10% in Germany for example.[9]
- The MW price for the entire wind farm with a capacity of 49.25 MW is therefore 743,000 EUR/MW. In Europe, at the time of installation in 2012, the typical investment costs for wind power plants were over 1 million EUR/MW, so at least 26% higher than for the FC project.[10]

The dynamic production costs (levelized costs of electricity) average 0.224 CNY/kWh (0.029 EUR/kWh) and thus close to 50% below the assumed figure during the project appraisal (0.433 CNY/kWh). In 2013/14, when wind feed-in was higher, the marginal costs were even 0.17 CNY/kWh. The figures are about 1/3 above the typical management costs for wind farms in China, as is evident from literature.[11] On the one hand, this can be explained by the high degree of curtailment, but it can also be seen as a quality attribute of the operator's management. In talks surrounding the ex post evaluation, wind farms with far worse performances and externally visible flaws, like rotor blades lying around, were mentioned. In any

[6] BNEF 2017: p. 38.

[7] ibid.

[8] GIZ 2017, p. 6.

[9] DWG 2015: Deutsche Windguard, Kostensituation der Windenergie an Land in Deutschland - Update, 12/2015, p. 8.

[10] ibid and discussions with wind farm developers in the context of the ex post evaluation.

[11] Energies 2015: Zifa Liu et al., The Economics of Wind Power in China and Policy Implications, Energies 2015, 8, 1529-1546, p. 1534f.

case, the operating costs are very low when compared to Europe, where typical prime costs for wind farms are cited at around 0.05 EUR/kWh.[12] The project was also appropriate regarding the use of funds at the micro- and macroeconomic level (allocation efficiency).

- The average feed-in tariffs for the wind farm are around 0.48 CNY/kWh (0.06 EUR/kWh). Initially, compensation was around 0.51 CNY/kWh, since 2017 it has been 0.42 CNY/kWh. With regard to the dynamic production costs and according to information from the executing agency, even with curtailment rates of up to 50% the project can still be operated whilst covering costs.
- The executing agency is a highly specialised company strongly anchored in the Chinese wind power market. The work of the executing agency seems very professional and is focused on quality and profitability. Even though no balance sheet was presented within the context of the ex post evaluation, an estimate based on factors like the executing agency's shareholdings produces a positive evaluation of financial soundness.
- The implementation of the investments was of very good quality, especially in the second project phase with FC participation. Overall, the result of the project is in line with the expectations during the appraisal, even if there were differences in quality between the components from phase 1 (local financing) and phase 2 (FC).
- Theoretically, similar impacts could have been achieved with different approaches. It might have been possible to increase the utilisation of wind power plants in Xinjiang, for example, by increasing the operational flexibility of existing coal-fired power plants or by expanding the transmission grid sooner. As in other countries, however, it was also impossible to foresee the success of wind power in China during the fast, decentralised expansion of power generation capacities at the time of the project appraisal; this also applies for the project implementation period.

With regard to project implementation, it should be noted that the period between project appraisal (2006/07) and the installation of the plants (2012) was long, and the project was not able to keep up with the dynamic development of China's wind power sector. The reasons for this listed in the project documentation were delays during the conclusion of the loan agreement and the tender for components (reporting to the Federal Ministry for Economic Cooperation and Development in 2010) and lengthy contract negotiations with component suppliers (reporting 2011). The long implementation period had direct impacts on the project's demo nature as the wind power boom was in full swing at the time of commissioning. On the other hand, the cost reductions led to very good production efficiency as price reductions for wind power components had positive impacts on the project returns.

Efficiency rating: 3

Impact

The project was intended to contribute to climate protection and to promoting economic development in the region. The indicator for the economic rate of return that was subsequently introduced yields a positive figure after external environmental effects are internalised, despite the additional costs for wind power when compared to coal power.

Indicator	PA target value	Ex post evaluation
Economic rate of return (of the overall investment)	n/a	4.7%

One very simplified estimation of the economic rate of return based on the costs and use of the wind farm results in a positive return of 4.7%. Benefits include the saved fuel costs from conventional power plants[13]

[12] DWG 2015, p. 6.

[13] Cambridge EPRG, 2017: University of Cambridge, Energy Policy Research Group: Reforming the Chinese Electricity Supply Sector: Lessons from International Experience, 03/2017, p. 11.

and a quantification of the positive environmental impacts of the wind farm by setting a carbon price of 47.50 EUR/tCO_2[14] on the emission factor of the Chinese power plant.[15]

If the feed-in tariffs for wind and coal-fired power plants are observed in isolation, the economic rate of return is negative. Due to the enormous coal resources in Xinjiang, the cost-based compensation for coal-fired power plants is significantly under the national average at 0.26 CNY/kWh and below the compensation for wind power (here: 0.48 CNY/kWh). So far, wind power in China has not been competitive when compared to conventional power generation on a pure cost basis without taking saved carbon emissions into account.[16]

The structural impacts of the project in the context of the massive increase in wind power capacity in the PR of China would have been clearer if they had been implemented earlier. However, the developments concerning the reduction of excess capacities for coal-fired power generation indicate that the Chinese energy system is transitioning into a system that is geared more towards renewable energy sources (see above, "Efficiency"). This development is also reflected in the development of the power plant fleet in Xinjiang. Between 2009 and 2016 the percentage of coal-fired power plants within the overall power production capacities in the province decreased from 78% to 68%. The percentage of capacity generated by wind power increased from 2% (2009) to 8% (2016) in the reference period. In the electricity mix, i.e. the actual grid feed-in, this development has been reflected to a lesser extent to date.[17] But in the longer term it can be assumed that the strong development of wind energy in Xinjiang will replace the building of capacities for coal-fired power plants.

The economic development of Xinjiang Province has been positive since the wind farm's commissioning. According to official Chinese statistics, per capita GDP between 2006 and 2016 increased by 10.6% per year on average (compounded annual growth rate (CAGR), not adjusted for inflation), similar to the rate for all of China (12.4% CAGR, not adjusted for inflation).[18] Population growth in Xinjiang was 1.6% per year in the same period.

Energy consumption in Xinjiang Province increased 22% per year between 2006 and 2015 from 36 TWh to 216 TWh. This sharp increase in comparison to the economic and population growth indicates that energy-intensive industries are establishing themselves in Xinjiang. The aluminium and steel industries in particular, but also the chemical industry, were mentioned in discussions. However, the expansion of these sectors was initially slowed down as the resultant environmental impacts were too extreme.[19]

Negative social and environmental impacts could not be identified during the inspection of the wind farm. It is located in a steppe-like region with very strong winds that is not very amenable to settlement. No traces of settlements or adversely affected flora and fauna were found in the immediate vicinity, similar to the situation during the project appraisal and the final inspection.

The demonstrative nature (lighthouse effect) of the project is estimated to be fairly low. At the time the plant was fully commissioned in 2012, 1 GW of wind power capacity had already been installed. But the knowledge gained by the executing agency and its subsidiaries was significant: after commissioning the co-financed project, the executing agency commissioned an additional 69 MW of wind power capacity in Xinjiang, mostly using 1.5-MW turbines, a larger category than before. A subsidiary also expanded its product portfolio with several turbines in the multi-megawatt class after the FC project.[20]

The added value of the FC for the executing agency was primarily derived from gaining expertise about international standards in the wind power industry. According to information from those responsible this

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[14] IMF 2014: Ian Parry, Chandara Veung, Dirk Heine, How much carbon pricing is in countries' own interest? The critical role of co-benefits, IMF Working Paper 14/174, 2014, p. 18.

[15] IEA 2017: International Energy Agency, CO_2 emissions from fuel combustion - Highlights 2017, p. 81.

[16] Discussions with wind project developers in the context of the ex post evaluation.

[17] NBS 2016: National Bureau of Statistics, Statistical Yearbook 2016, Appendix 1–11.

[18] NBS 2018: Annual Statistics / Annual Statistics per Province, Gross Domestic/Regional Product, .
The figures from the World Bank adjusted for purchasing power present an average growth rate of 8% (CAGR 2006–2016) for all of China (https://data.worldbank.org/indicator — GDP per capita, PPP, 2011 constant international USD). Data adjusted for purchasing power are not available for the Xinjiang region.

[19] Discussions with an energy research institute in Beijing conducted within the context of the project evaluation, November 2017.

[20] Discussions within the context of the project evaluation with a wind farm project developer in Beijing, November 2017.

included project planning, the selection of components, installation and commissioning, but primarily also the training of expert staff for management. In addition, the financing conditions and access to international components were also mentioned as benefits of FC financing for the executing agency. However, it can be assumed that the wind farm would still ultimately have been realised even without the subsidisation of the financing terms.

Impact rating: 3

Sustainability

From today's perspective the continued operation of the wind farm seems to be ensured, primarily due to the executing agency's high level of professionalism and the profitability of the project, with dynamic production costs of 0.029 EUR/kWh and an average feed-in tariff of 0.06 EUR/kWh. The management makes an excellent impression. Spare parts are directly available on site and smaller repairs are performed directly by the operator's own staff. Site-monitoring is centralised as the executing agency maintains additional wind farms in the Dabancheng region. The scale effects achieved are also reflected in the low specific prime costs (see above, "Efficiency").

Despite the limitations on wind power development in Xinjiang (see above, "Effectiveness"), the stability of the executing agency is deemed positive: firstly, because the provincial government is the largest shareholder, and secondly, because the executing agency is developing its business towards other provinces and new business models in the electricity market (e.g. charging stations for electromobility).

At the project level, it should be noted that the measures for improving power feed-in (see above) are likely to lead to an improvement in returns in the short to medium term. When compared to other wind farms, the proximity to the load centre of the provincial capital of Urumchi should also have a positive impact on usage (dispatch). According to information from the executing agency, thought has been given as to whether air pollution should be combated by turning off various coal-fired power plants in the area around the city.

Due to the encouraging prospects with regard to the necessary political focus on exhausting capacities for renewable energy generation, and in view of the operator's professional and sound approach, it can be assumed that the developmental impacts will also continue in the future, or even increase.

Sustainability rating: 2

Notes on the methods used to evaluate project success (project rating)

Projects are evaluated on a six-point scale, the criteria being **relevance, effectiveness, efficiency** and **overarching developmental impact**. The ratings are also used to arrive at a **final assessment** of a project's overall developmental efficacy. The scale is as follows:

Level 1	Very good result that clearly exceeds expectations
Level 2	Good result, fully in line with expectations and without any significant shortcomings
Level 3	Satisfactory result – project falls short of expectations but the positive results dominate
Level 4	Unsatisfactory result – significantly below expectations, with negative results dominating despite discernible positive results
Level 5	Clearly inadequate result – despite some positive partial results, the negative results clearly dominate
Level 6	The project has no impact or the situation has actually deteriorated

Rating levels 1-3 denote a positive assessment or successful project while rating levels 4-6 denote a negative assessment.

Sustainability is evaluated according to the following four-point scale:

Sustainability level 1 (very good sustainability): The developmental efficacy of the project (positive to date) is very likely to continue undiminished or even increase.

Sustainability level 2 (good sustainability): The developmental efficacy of the project (positive to date) is very likely to decline only minimally but remain positive overall. (This is what can normally be expected).

Sustainability level 3 (satisfactory sustainability): The developmental efficacy of the project (positive to date) is very likely to decline significantly but remain positive overall. This rating is also assigned if the sustainability of a project is considered inadequate up to the time of the ex post evaluation but is very likely to evolve positively so that the project will ultimately achieve positive developmental efficacy.

Sustainability level 4 (inadequate sustainability): The developmental efficacy of the project is inadequate up to the time of the ex post evaluation and is very unlikely to improve. This rating is also assigned if the sustainability that has been positively evaluated to date is very likely to deteriorate severely and no longer meet the level 3 criteria.

The **overall rating** on the six-point scale is compiled from a weighting of all five individual criteria as appropriate to the project in question. Rating levels 1-3 of the overall rating denote a "successful" project while rating levels 4-6 denote an "unsuccessful" project. It should be noted that a project can generally be considered developmentally "successful" only if the achievement of the project objective ("effectiveness"), the impact on the overall objective ("overarching developmental impact") and the sustainability are rated at least "satisfactory" (level 3).